3

Treatment Manual

Nonchemical Treatments

Heat, Hot Water Immersion Treatment

Contents

Hot Water Immersion Treatment (in General)

Principle

Hot water immersion treatment (also called hydrothermal treatment) uses heated water to raise the temperature of the commodity to the required temperature for a specified period of time. This is used primarily for certain fruits that are hosts of fruit flies, but may also be used for nursery stock for a variety of pests.

Schedules

Refer to the appropriate section in the Treatment Manual for Treatment Schedules. The time/temperature relationship varies with the commodity and pest. Typically, the pulp temperature is raised using water heated to between 115°F and 118°F for a prescribed period of time.

Procedures

- Before the start of each treatment, examine the facility for proper operation of the heating, circulation, and recording equipment. Examine continuous flow equipment (submerged conveyor belt) at the start of each day or run
- Commodities subject to size restrictions require a preliminary culling procedure to eliminate oversized items prior to treatment
- Conduct all treatments in an approved tank
- Do not refrigerate commodity before treatment
  - The commodity must be at or above the prescribed minimum temperature if specified in the Treatment Schedule
- Entire treatment will be under the general monitoring of APHIS, and may be further governed by a signed Work Plan (for foreign facilities) or Compliance Agreement (for domestic facilities)

- Load immersion tanks in a manner approved by the U.S. Department of Agriculture (USDA), usually using baskets with perforations that allow adequate water circulation and heat exchange
- Number each treatment container or lot before placing in the immersion tank
- Record the temperature and duration of each hot water dip with an automatic temperature recording system
  - A responsible employee of the packing company must indicate on the printed temperature record the starting time, lot number, duration of each treatment, and initial each entry
  - An alternative recording system can be used only with prior APHIS approval
- Stamp all boxes of hot water-treated fruit, *Treated with Hot Water, APHIS-USDA,* together with the numerical designation APHIS has assigned to the particular treatment facility
- When treatment is complete, promptly move commodities treated at origin to an insect-free enclosure
  - Maintain the insect-free commodities throughout the shipping process, this can be accomplished by using insect-proof containers, screened or enclosed rooms, doors with air-curtains, or some combination of the above

Checklist of USDA-APHIS Minimum Requirements for Hot Water Immersion Treatment Facilities: General Requirements

Proposals Submission

Follow the accepted protocol when submitting proposals for new hot water facilities. (Under the chapter **Certifying Facilities**, see the discussion titled, **Protocols for Foreign Treatment Facilities** on **page 6-5-7**).

On-Site Inspection Option

When the construction is 75 percent complete, the firm can request APHIS to make an on-site inspection. This interim inspection is optional. However, a final inspection is required as well as performance tests of the equipment. All costs involved must be prepaid by the requesting firm.

Facility Design

APHIS does not provide construction details, but only this checklist of minimum requirements. Design and construction of the hot water facility is the responsibility of the owner, in consultation with an

engineering firm. (Engineering firms and sources of supply are provided in Appendix B.) To take into account variations in facility size, availability of materials, economic feasibility, and individual preference, APHIS allows a wide range of design flexibility.

Although each facility is somewhat unique, there are two basic designs for hot water facilities. The two types are referred to as the *batch system* and the *continuous flow system.*

Batch System (Sometimes Called "Jacuzzi System")

Most hot water immersion treatment facilities are the batch system type. In this system, baskets of fruit are loaded onto a platform, which is then lowered into the hot water immersion tank where the fruit remain at the prescribed temperature for a certain length of time, then are taken out, usually by means of an overhead hoist. In this system, the treatment chart must indicate (by an identifiable marking) when a fruit basket is prematurely removed from the tank. Other alternatives include a solenoid switch, sensor, or similar device that disengages whenever a basket is removed from the treatment tank, or a locking device to make it physically impossible to remove the fruit until the treatment is fully complete.

Continuous Flow System

In the continuous flow type of system, the fruit are submerged (either loosely or in wire or plastic mesh baskets) on a conveyor belt, which moves slowly from one end of the hot water tank to the other. Belt speed is set to ensure the fruits are submerged for the required length of time. This system requires an instrument to monitor the speed of the conveyor belt. This can be accomplished by attaching a speed indicator (encoder) to the gear mechanism. The belt speed is recorded on the same chart as the time and temperature, and also indicates whether the belt is moving or stopped during the treatment cycle. Smaller fruits require less treatment time than larger fruits. Therefore, conveyor belt speed should be adjustable to accommodate treatments of different lengths of time. As an alternative, the belt speed may remain constant, but the length of the submerged portion of the belt is adjusted according to the length of treatment time required for the particular size of fruit. The conveyor must prohibit either forward or backward movement of the fruit during treatment (due to flotation).

Some operators believe that treating fruit while it passes through the system on a conveyor belt is an advantage. Few new systems of this type were built after 1990, presumably because mechanical fruit damage (scratching of the peel) often occurs if the fruit are not in baskets. The system also occupies much more floor space in the plant than a batch system.

Water Quality

Preventing microbial contamination of fruit at the plant is expected. Chlorinate and maintain any water used for washing, dipping, or showering the fruit at a level of 50 to 200 parts per million (ppm). Also, chlorinate hydrocooling tanks to the same level. This level is easier to maintain if the water is first filtered and run through a flocculation

process to remove organic material that would otherwise bind with the chlorine. Sample water regularly for microbial contamination. To maintain sanitary conditions, change water as necessary. Implement standard operating procedures to include water change schedules for all processes that use water. To ensure the safety of the produce, clean and sanitize surfaces that come into contact with water, such as wash tanks, hot water tanks, and hydrocooling tanks as often as necessary. To ensure efficient operation, routinely inspect and maintain equipment designed to assist in maintaining water quality, such as chlorine injectors, filtration systems, and backflow devices.

Periodic monitoring is critical, because chlorine levels above 300 ppm can result in metal corrosion.

Electrical and Electronic Components

Wiring

Electrical wiring throughout the facility must meet both international as well as local safety code requirements. To eliminate shock hazard, earth grounding is required for all electrical wiring located in the vicinity of water. To prevent damage, shield wires inside metal or PVC conduit.

Computers and Microprocessors

To maintain accuracy and reliability, place computers and microprocessors in a climate-controlled (air-conditioned) room. This room should be above tank level, provide a clear view of the treatment tank(s), and be lockable. This room can also serve as an office for the inspector.

Commercial Line Conditioner (Surge Protector)

A commercial line conditioner is recommended for use with computers and microprocessors to provide protection from voltage irregularity (power surges), noise reduction, and harmonic distortion.

Electrical Generator

In the event of a power outage and to provide a secondary source of electricity to enable continued plant operation, an electrical generator is recommended as a backup power supply.

Fruit Sizing Equipment

In the Treatment Schedule, the duration of hot water immersion depends on the particular weight class of the fruit being processed. It is very important to have accurate sizing equipment that sorts the fruit into groups, either by diameter or by weight. (Weight sorting is

the preferred method.) Not more than 10 percent of the fruit in any batch are allowed to weigh more than the maximum weight for its particular weight class. Of these, none are allowed to be more than 25 grams overweight. The APHIS Inspector must periodically record the weights of 100 fruits in a particular batch that has been sorted prior to treatment to ensure that the accuracy of the sizing equipment stays within these parameters. If the weight range is too broad, recalibrate the equipment. Since it is possible for the immature stages of fruit flies to survive in fruit that are undertreated for their weight, it is especially important to ensure that all fruits are sorted accurately into precise weight classes, as required by the treatment.

Boilers and Thermostatic Controls

Adequate Water Heating Capacity

The hot water facility must have adequate water heating capacity (i.e., a powerful enough boiler), and accurate enough thermostatic controls to hold the water temperature at or above the temperatures prescribed in the Treatment Schedule for the given length of time. A boiler used for the purpose of heating the water in a two-tank batch system typically needs an output rating of approximately 1,000,00 BTU, or 30 horsepower.

Thermostatic Controls (Set Point)

APHIS requires that the thermostatic controls be automatic. The temperature set point(s) are determined and approved during the official performance test, and must be high enough to ensure the water in the treatment tank will meet or exceed the minimum treatment temperature prescribed for the fruit. Once approved, do not tamper with the temperature set points. Temperature set points must remain constant for the entire shipping season. However, if the operator of the facility requests a change in set points, the inspector should conduct a new performance test. If this test is unsuccessful, revert the tanks to their prior set points.

Multiple Set Point Option

Managers of some facilities prefer to use two set points for each tank. In this type of system the initial dip temperature (set point number one) is set slightly higher for the first five minutes. The second set point is the temperature to be maintained for the remainder of the treatment. Verify the set points during the official performance test, and the same procedure must be repeated on each subsequent commercial treatment. Using two set points is not required, however, two set points makes it easier for the tank to pass its performance test. This system works only for tanks that treat only one cage (basket) of fruit at a time.

Tanks are not allowed to have any set point that is lower than the standard treatment temperature for the commodity being treated (115°F in the case of mangoes).

Water Circulation

Install a water circulation system in the tank to provide uniform water temperatures throughout the treatment process and to avoid the formation of cool pockets during treatment. To guarantee that the equipment is not turned off during the treatment process, the controls for the circulation pumps or propellers must be tamper resistant. For the safety of personnel working in the area, shield pulleys on all pumps located within six feet of the floor.

Temperatures recorded from the various sensors must not vary by more than 1.8°F (1°C) at any given time after the fruit have been immersed for the first 5 minutes of treatment.

Using a flotation barrier, keep the fruit at least 4 inches (10.2 centimeters) below the water surface during the treatment.

Temperature Sensors

Type of Sensor

Permanently install platinum 100-ohm resistive thermal detectors (RTD sensors) in the lower third of the tank. The resistance of an RTD sensor linearly changes with temperature, whereas thermistors and thermocouples are nonlinear and less stable. Major advantages of RTD sensors include long-term stability, high signal levels, and overall accuracy of the system. Place the sensor unit within the distal 1 inch (2.54 centimeters) of the sensor rod. The sensor must have an outer sheath of 0.25 inch (6.4 millimeters) or less in diameter.

Number of Sensors Required and Their Placement

For continuous flow systems, the minimum number of sensors required is at least 10 per tank, which must be spaced throughout the length of the conveyor. For batch systems, the requirement is at least 2 sensors per tank. However, in tanks that treat multiple baskets (cages) of fruit, there must be at least 1 sensor per basket position. (A tank with 4 basket positions, for example, would require at least 4 sensors). In both the batch and continuous flow systems, install sensors in the lower third of the tank.

Tank Access for Temporary Placement of Portable Sensors

The hot water tank must be designed to accommodate the temporary placement of numerous portable sensors or probes to be used during the performance testing procedure required for certification or recertification. During the testing procedure and at the direction of the inspector who conducts the performance test, position the temporary sensors throughout the load of fruit. The facility is required to purchase and have available 24 portable thermistor or thermocouple sensors (each with its own flexible cord at least 10 feet in length), and a portable temperature monitor that reads to the nearest one-tenth of a degree.

Certified Glass-Mercury Thermometer

The treatment facility is required to have at least one high-accuracy, water-immersible, certified glass-mercury stick thermometer on the premises at all times. This thermometer must be accurate to 0.1°F (or C) and will cover the range between 113°F and 118°F (45°C to 47.8°C). It will be used as the standard against which all sensors are calibrated. Normally, one glass thermometer is left hanging in each tank during the performance testing procedure.

Temperature Recorder

Use an automatic temperature recorder (strip chart or data logger) to record the time and temperature during each treatment.

Automatic Operation

The instrument used for recording the time and temperature must be capable of automatic operation whenever the hot water treatment system is activated.

Long-Term Recording

The recording equipment must be capable of nonstop recording for an extended period of time. Continuous flow systems require recording equipment capable of operating for up to 12 consecutive hours.

Recording Frequency

The time interval between prints will be no less than once every two minutes. Alternatively, a strip chart system can be used that gives continuous color pen lines. The numerical print or pen line representing each temperature channel (sensor) must be uniquely identified by color, number, or symbol. It is not necessary to record temperatures from sensors located in portions of the tank not in use.

Accuracy

The combined accuracy of the entire temperature recording system (i.e., sensors, controllers, and recorders) must be within 0.5°F (or 0.3°C) of the true temperature (as verified by a certified glass-mercury thermometer).

Repeatability

When used under field conditions over an extended period of time, the recording equipment must be capable of repeatability to within 0.l°F (or C) of the true calibrated readings. Failure to maintain reliability, accuracy, and readability in a previously approved instrument will result in cancelling approval. The design construction and materials must be such that the typical environmental conditions (including vibration) will not affect performance.

Calibration

Individually calibrate channels (sensors) against a certified glass-mercury thermometer reading in tenths of a degree Fahrenheit or Centigrade, within the range of 113°F to 118°F (45°C to 47.8°C). The engineering firm that installs the recording equipment must also calibrate it. (Calibration equipment often used for this purpose includes, for example, a Decade instrument and relay range cards.) Calibrate the sensors at or near the fruit treatment temperature (around 115°F), but not at 32°F.

Range

The recorder must be programmed to cover the entire range between 113°F to 118°F (45°C to 47.8°C), with a resolution of one-tenth of a degree. The range should not extend below 100°F (37.8°C) nor above 130°F (54.4°C). If the range band of the recorder is wider than this, restrict it (narrowed) with proper programming.

APHIS-Approved Recorder Models

Some recorder models currently on the market are not approved by APHIS for various reasons. For example, if the recorder only displays the sensor numbers and temperatures without making a printout on paper; or if it prints out the temperature data only after the treatment has been completed it is not approved by APHIS. (These are known as “memory loggers.”) These two types of recorder models do not provide an adequate level of monitoring during treatment. *Also, revolving circular charts are not acceptable because of the difficulty in reading fractions of one degree.*

Temperature recorder models presently approved by APHIS are listed below. They can be either of the strip chart or data logger type. Some have adjustable chart speeds. Additional temperature recorder models may be added to this list upon petition to the Treatment Quality

Assurance Unit[1] at CPHST. To seek APHIS approval for recorder models not listed, submit the manufacturer's technical brochure to the Treatment Quality Assurance Unit[1] at CPHST for evaluation.

Approved Strip Chart (Pen) Recorder Models

- Chessel 346
- Honeywell DPR 100A (3-channel capability)
- Honeywell DPR 100B (6-channel capability)
- Honeywell DPR 100C (3-channel capability)
- Honeywell DPR 100D (6-channel capability)
- Honeywell DPR 180 (36-channel capability)
- Honeywell DPR 1000 (6-channel capability)[2]
- Honeywell DPR-3000, version D4 (32-channel capability)[3]
- Honeywell Versaprint-131 (12-channel capability)
- Molytek 2702
- Neuberger P1Y
- Toshiba AR201
- Tracor 3000
- Yokogawa Micro-R l80

Approved Data Logger Recorder Models

- ASICS Systems B & C
- Chino AA Series
- Cole Parmer (32-channel capability)
- Contech (10-channel capability)
  - Model: Smart Seda
- Flotek (must be attached to a printer)[4]
- HACCP Warrior PTR- 4 (4-channel capability)
- HAACP Warrior PTR- 10 (10-channel capability)

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2 The Honeywell DPR-3000 must be the high-accuracy version, with model number beginning with D4. It has the versatility of being used either as a strip chart or data logger.

3 The Honeywell Versaprint-131 was no longer manufactured after 1996.

4 The Flotek Company went out of business in 1991. However, used instruments occasionally become available, and a few new instruments may still be stocked by companies such as ASICS.

- Honeywell DPR I00B (6-channel capability)[5]
- Honeywell DPR-1500 (30-channel capability) [6]
- Honeywell DPR-3000, version D4 (32-channel capability) [7]
- IBM-PC (must be attached to a printer)
- Koyo, Model Direct Logic DL 350, with Hidro Soft
- Nanmac H30-1
- National Instruments (hardware + software) (64-channel capability)
- Omega OM-205
- Omega OM-503
- Ryan Data Mentor (12-channel capability)
- Tracor Westronics DDR10

Chart Paper Specifications

Celsius or Fahrenheit Scale

Temperature can be recorded either in Fahrenheit or Celsius, although Fahrenheit is preferred by APHIS.

Scale Deflection

Scale deflection on the strip chart paper must be at least 0.10 inches for each degree Fahrenheit, or at least 5 millimeters for each degree Celsius. Greater width between whole degrees, however, is preferred. Between each line representing one degree, there must also be finer lines, each representing subdivisions of one-tenth or two-tenths of a degree, in the range of 113°F to 118°F (45°C to 47.8°C).

Sample Required

Submit a sample of the strip chart or numerical printout made by the recording equipment to CPHST. It should be in the exact format to be used at the facility during the treatment cycle. Each symbol on the print wheel (or ink color, in the case of strip charts) must correspond to and identify the particular sensor that it represents.

Chart Speed

Chart speed for strip chart recorders must be no less than one inch for every ten minutes of treatment time. (One inch for every five minutes is preferred). Thus, for a typical ninety minutes of treatment, the total length of the chart will be at least nine inches long (preferably eighteen inches).

5 The Honeywell DPR-1500 was no longer manufactured after 1990.

6 The Honeywell DPR-3000 must be the high-accuracy version, with model number beginning with D4. It has the versatility of being used either as a strip chart or data logger.

7 The Flotek Company went out of business in 1991. However, used instruments occasionally become available, and a few new instruments may still be stocked by companies such as ASICS.

Chart Length

The chart paper must be long enough to display at least one entire treatment. Continuous flow systems must contain enough chart paper to continuously record temperatures for up to twelve consecutive hours.

Alarm System

An alarm is required for all batch (Jacuzzi) systems. In order to notify packinghouse employees that a treatment has been completed for a particular basket (cage), install an alarm system. This system can be an audible noise (such as a horn, buzzer, or bell) or a highly visible light attached to a timing device located on the equipment that indicates time and temperature. Some facilities use both a noise and a light. To avoid "overcooking," the alarm system alerts the operator of the hoist to remove a basket from the tank at the end of treatment.

Safeguarding the Treated Fruit

Layout and Flow Pattern

Design the flow pattern of the fruit moving through the hot water treatment process to ensure that fruit waiting to be loaded into the hot water immersion tank cannot become mixed with fruit that has already completed treatment. Submit a drawing showing the proposed layout of the packinghouse to CPHST for approval.

Garbage Disposal

In order not to attract fruit flies, place cut fruit, culled fruit, rotting fruit, and miscellaneous garbage into covered containers and remove from the premises daily.

Quarantine Area

Bring treated fruit to an insect-free enclosure immediately after treatment. The treated fruit must remain there until loading into insect-proof shipping containers. The designated enclosure is usually a screened room. Packing line equipment, hydrocooling equipment, and a cool storage room (if any), should be located in this area, but this equipment is not a requirement. To prevent the movement of untreated fruit (accidentally or intentionally) into the insect-free quarantine area enforce effective procedures.

Screening and Other Materials

Ordinary window screen or mosquito netting (at least 100 mesh per square inch) is sufficient to exclude fruit flies. Inspect it regularly and repair it as often as needed. Solid glass, concrete, drywall, or wooden walls are also acceptable.

Air Curtain

Place on the wall or ceiling prior to entering any quarantine area an apparatus that generates a high-velocity wind barrier or air curtain (such as fans or blowers and associated air-directing chambers or enclosures such as baffles, boxes, etc.). This device must exclude the possible entry of fruit flies into the insect-free enclosure. (For facilities approved prior to July 1, 1997, vertically hang clear plastic flaps, as minimally required, at the doors to the insect-free enclosure.

Loading of Treated Fruit

When not in use, close doors leading from the quarantine area to the loading dock. When loading, truck vans and containers must form a fly-proof seal with the exterior wall. Prior to loading, inspect and disinfect truck vans and containers. If wooden pallets are used, they must be completely free of wood-infesting insects and bark. Apply a numbered APHIS seal to each container before its departure.

Pretreatment Warming Options

Prewarming the fruit is sometimes desirable in order to meet the APHIS requirement that all fruit pulp temperatures be at least 70°F before the commencing treatment. (This usually ensures that the required minimum treatment temperature of 115°F is achieved within the first 5 minutes of treatment.) The requirement of having fruit at or above 70°F (in the case of mangoes) prior to hot water treatment does not have to be met: (a) when the fruit have come directly from a refrigerated room; (b) when the weather is rainy or cloudy; or (c) in the early morning hours. These conditions can cause a treatment facility to close temporarily until the fruit pulp temperature has sufficiently warmed to allow treatment.

It is the usual practice at many facilities to use the hoist to hang a basket of fruit a few inches above the surface of the hot water tank prior to submerging it. However, except for the bottom layer of fruit in the basket, the fruit do not absorb a sufficient amount of heat to make this a practical means of prewarming the entire basket load. To accelerate the prewarming process, several viable options are available. APHIS suggests the following methods for pretreatment warming:

Treatment Tank

In tanks that treat a single basket (cage) of fruit at a time, preheat within the tank itself by using a timer or delay switch. (The extra time in the water is not considered part of the treatment, but is in addition to the treatment.) This approach, however, is not feasible in a multibasket tank (in which the baskets enter the tank at different times), and is not an approved option in this instance.

Separate Tank

A separate hot water tank can be used for preheating purposes.

Heated Air

Hot air can be blown onto the fruit.

Heated Room

The fruit can be placed in a heated room.

Direct Sunlight

The fruit can be exposed to direct sunlight (which can be magnified through glass).

Post-Treatment Cooling Options

Cooling the fruit after hot water treatment is not an APHIS requirement. However, from the standpoint of fruit quality, many facilities choose to install a system to cool the fruit after removal from the hot water.

Refrigerated Room

Hot water treated mangoes cannot be moved directly to a refrigerated room until at least 30 minutes following treatment. Allowing the fruit to simply stand for at least 30 minutes after being removed from the hot water tank is thought to be helpful in killing immature stages of fruit flies because the mangoes complete their “cooking” process during that time. The recommended storage temperature for mangoes is between 55°F and 57°F (12.8°C and 13.9°C) at 85 percent to 90 percent relative humidity. These temperatures delay softening and prolong storage life to approximately 2 to 3 weeks.

Fans

APHIS allows the use of fans in the screen room to blow air over the fruit as soon as they are removed from the hot water tank (if desired). However, the ambient air cannot be less than 70°F.

Hydrocooling

APHIS allows the use of a cool water tank or shower system, but with the following provisions:

- During the waiting period and hydrocooling period, safeguard the mangoes in a room or tunnel, separate from the hot water tanks
- Water temperature used during hydrocooling must be 70°F or above
- Water used for hydrocooling should be chlorinated (50 to 150 ppm)
  - Any other chemicals, such as fungicides, are optional, but must be approved in advance by the FDA

Changes

Hot water immersion treatment facilities whose construction was approved under earlier guidelines can continue to operate with APHIS approval. Newer facilities, however, are required to meet the current requirements outlined in this checklist, which in most cases are more strict.

Once CPHST has formally approved the plans and drawings for a hot water immersion treatment facility, the facility can make no further changes in the equipment without APHIS approval. Any proposed changes or improvements must be described in writing (with accompanying drawings, if necessary) and must be approved by APHIS in writing. Examples of proposed changes include adding additional treatment tanks, adding a cold storage room, and changing the model of the temperature recorder.

Safety and Health Checklist

- Adequate lavatory
- Admission of children or unauthorized persons into the treatment and packing areas prohibited if not accompanied by a responsible employee
- Approved safety ladders or walkways (catwalks, etc.) for observing treatment tank operations
- Electric power meets safety code requirements
  - Electrical wiring, including switches and other connections, contained in metal or PVC conduit and grounded to prevent electrical shock
- Engines, pulleys, drive belts, and other hazardous moving parts, if located within six feet of floor level, guarded with a safety shield or barrier
- Fire extinguisher located near the boiler
- First-aid kit located near moving machinery
- Hard hats for workers and visitors in the treatment and loading areas must wear (this is optional if not required by local regulations)
- Steam and hot water pipes insulated or otherwise protected
- Sufficient lighting provided in working areas

Dirty water in the tanks is a health concern, as well as an embarrassment to the operator. The APHIS inspector can provide advice on how often the water should be changed. In addition, to monitor the turbidity of the water, APHIS recommends that operators install a light sensor in each tank.

Work Plan

A Work Plan is a formal agreement signed by a representative of each treatment facility in a particular country, the Agriculture Ministry of the host government, and by USDA-APHIS. Work Plans govern the day-to-day operations of each facility and can be improved from one year to the next. Work Plans usually contain additional provisions not included in this checklist.

Fruit exporters are required to operate under general APHIS monitoring and to be in full compliance with all APHIS regulations as outlined in detail in the current Work Plan. The operator of the facility, as well as the inspector assigned to the facility, should each keep a copy available to resolve any disputes.

Start-Up Costs and Resources

Currently, a modern two-tank system typically costs from $100,000 to $200,000 to build. Additional funds, about $40,000 to $50,000, are needed for installation. These costs do not include the land, building, and the various infrastructure that may be needed, such as fruit sizing equipment, packing tables, and cooling rooms. APHIS requires the exporter to sign a cooperative service agreement and to make an advance cash deposit into a trust fund used to pay for transportation, lodging, meals, incidental expenses, and salaries of inspectors sent on temporary duty to the facility to conduct the official performance tests and to monitor treatments. If several treatment facilities are located near one another, they will sometimes be allowed to share the cost of services provided by one inspector. APHIS is a regulatory agency of the U.S. Department of Agriculture (USDA) and cannot become involved in financing commercial enterprises.

See Appendix H, **Reference Guide to Commercial Suppliers of Treatment and Related Safety Equipment** for manufacturers, suppliers, engineering firms, and consultants for hot water immersion treatment facilities. These resources are found under the following categories:

- Balances, Portable
- Batch Systems (Completes Installations)

- Chain Hoist (Electronic)
- Consultants
- Continuous Flow Systems (Complete instrumentations)
- Digital Thermistor Instrument (hand-held) and Portable Sensors (used in Performance Test)
- Fruit Crates, (Plastic)
- Fruit Sizing Equipment (Automatic)
- Safety Equipment
- Screening and Netting (Fly-Proof)
- Steam Boilers
- Temperature Recorders (Including Installation)
- Temperature Sensors (RTD, 100 ohm)
- Thermometers, Glass-Mercury, Certified Precision (used as a calibration standard)